North American Cranberry Researcher and Extension Workers Conference

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Managing Surface Water Inputs to Reduce Phosphorus Losses from Cranberry Farms

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Managing Surface Water to Reduce Phosphorus Loss from Cranberry Bogs

Casey Kennedy
USDA-ARS

NACREW, Plymouth, Massachusetts USA
August 30, 2017

Why Water Quality?

- TMDL
- Total Maximum Daily Load
- Implemented to meet water quality standards of Clean Water Act
- Point and non-point discharges

EPA's 303d List

EPA United States Environmental Protection Agency

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Impaired Waters and TMDLs

- Impaired Waters and TMDLs Home
- Program Vision
- Impaired Waters and TMDLs throughout the U.S
- Technical Tools and Resources

Program Overview: 303(d) Listing of Impaired Waters

What is a 303(d) list of impaired water?

The term "303(d) list" or "list" is short for a state's list of impaired and threatened waters (e.g. stream/river segments, lakes). States are required to submit their list for EPA approval every two years. For each water on the list, the state identifies the pollutant causing the impairment, when known. In addition, the state assigns a priority for development of Total Maximum Daily Loads (TMDL) based on the severity of the pollution and the sensitivity of the uses to be made of the waters, among other factors (40 C.F.R. §130.7(b)(4)).

In general, once a water body has been added to a state's list of impaired waters it stays there until the state developes a TMDL and EPA approves it. EPA reporting guidance provides a way to keep track of a state's water bodies, from listing as impaired to meeting water quality standards. This tracking system contains a running account of all of the state's water bodies and categorizes each based on the attainment status. For example, once a TMDL is developed, a water body is no longer on the 303(d) list, but it is still tracked until the water is fully restored.

How do states identify impaired waters?

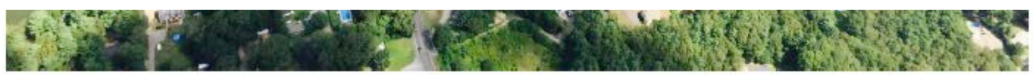
States may use any number of ways to determine whether or not a water body meets the water quality standard. However, federal regulations say states must evaluate "all existing and readily available information" in developing their 303(d) lists (40 C.F.R. §130.7(b) (5)). This means that states cannot select what data/information they use and purposely disregard other. EPA's regulations contain a nonexclusive list of information that must be considered.

Monponsett Pond TMDL

Draft West and East Monponsett Pond System
Total Maximum Daily Loads
For Total Phosphorus

(CN 446.0)

A key to the success of this TMDL is the reduction of TP load from local cranberry bogs whose discharge is tributary to the lake. The cranberry bog discharge must be limited to 0.5 kg/ha/yr (0.45 lb/ac/yr), the same as recommended in Mattson (2009) and used in White Island Pond (Mattson, 2015). This level of phosphorus export can be achieved by limiting water discharge rates to 3.5 acre-feet per acre of bog (see below) with average total phosphorus concentrations of 0.05 mg/l (the acceptable concentration of inputs to lakes from EPA, 1986 "Gold Book"). A



COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
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MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION
MARTIN SUUBERG, COMMISSIONER
BUREAU OF WATER RESOURCES
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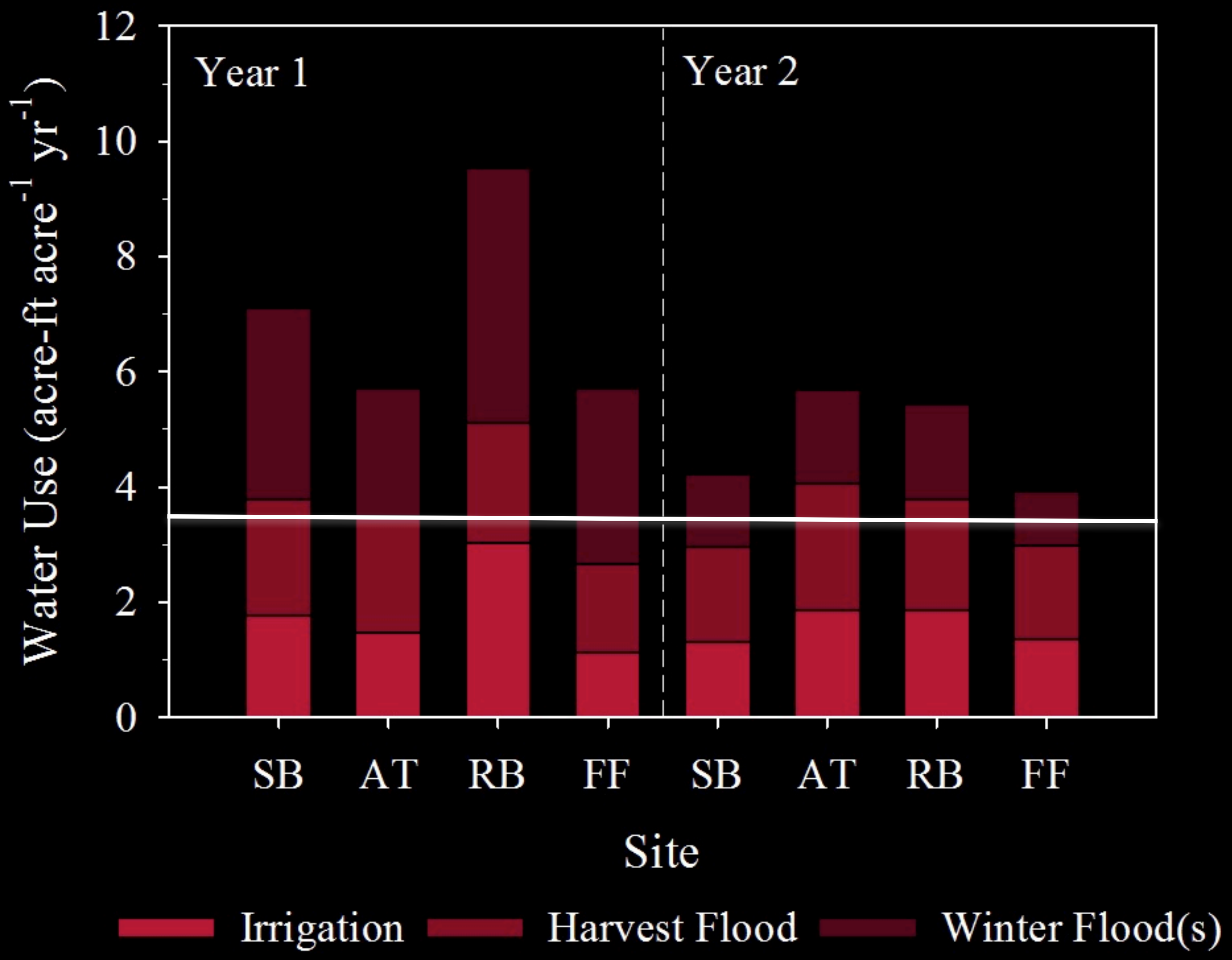
October 24, 2016

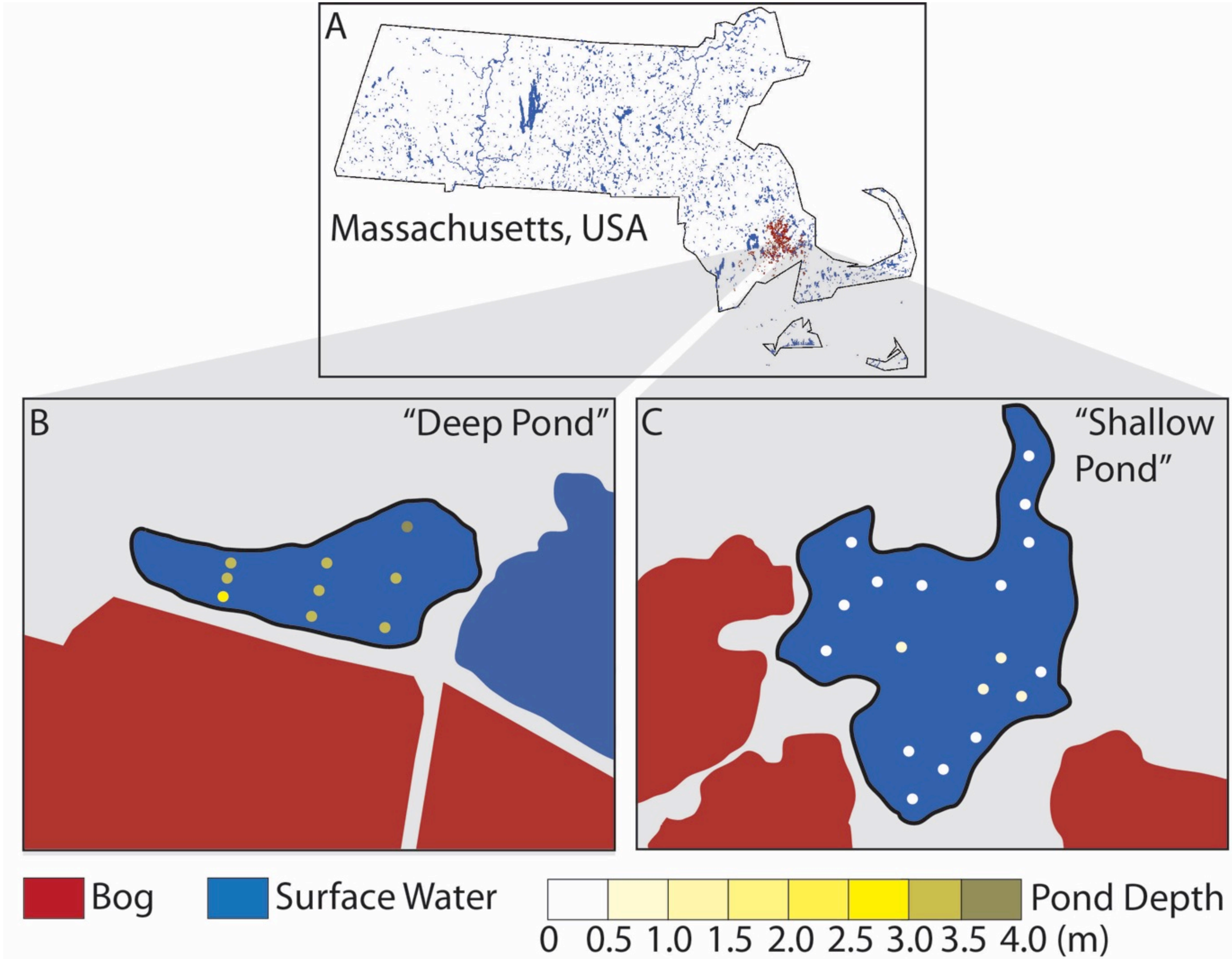
Mass DEP, 2016, Draft West and East Monponsett Pond System Total Maximum Daily Loads For Total Phosphorus, 126 pages



Kennedy, C. D., P. Jeranyama, and N. Alverson (2017), Agricultural water requirements for commercial production of cranberries, *Canadian Journal of Soil Science* 97:38–45. doi:10.1139/cjss-2015-0095

Objective

- Develop low-cost, field-scale method for reducing the P concentration of surface water
  - **Rationale:** Industry uniquely adapted for traditional water treatment methods
  - ✓ Manage large water volume
  - ✓ Existing delivery mechanism (i.e., sand barge)
  - **Lab Experiment:** Test several common P-reducing materials
  - **Field Study:** Apply one material to two irrigation ponds, varying in area and depth


A
Massachusetts, USA
B
"Deep Pond"
C
"Shallow Pond"
Bog
Surface Water
Pond Depth
0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 (m)

Gypsum

- Calcium sulfate ($CaSO_4$)
- Neutral (no pH effect)
- Moderately soluble in water (S = 0.26 g/100g)
- Drywall, plaster, and fertilizer

Slaked Lime

- Calcium hydroxide ($Ca(OH)_2$)
- Basic (raise pH)
- Moderately soluble in water (S = 0.17 g/100g)
- Waste water coagulant, paper production, pickling foods, Ca supplement

Calcite

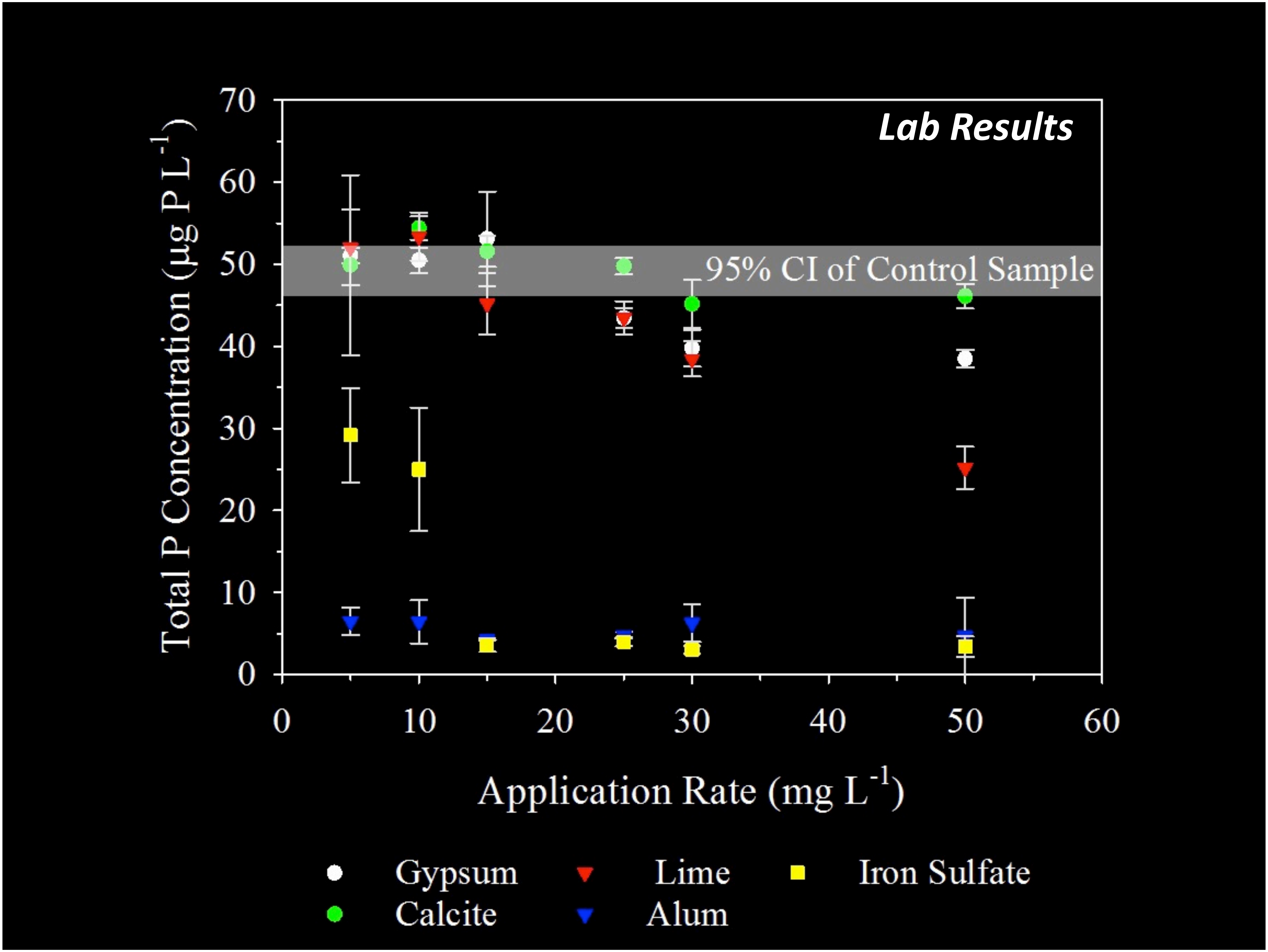
- Calcium carbonate ($CaCO_3$)
- Basic (raise pH)
- Weakly soluble in water ($S = 6.2x10^{-4}$ g/100g)
- Primary constituent of limestone and marble
- TUMS

Iron Sulfate

- Ferric sulfate ($Fe_2(SO_4)_3$)
- Acidic (lower pH)
- Moderately soluble in water (S = 28.8 g/100g)
- Waste water coagulant, dye
- Composition of Mars

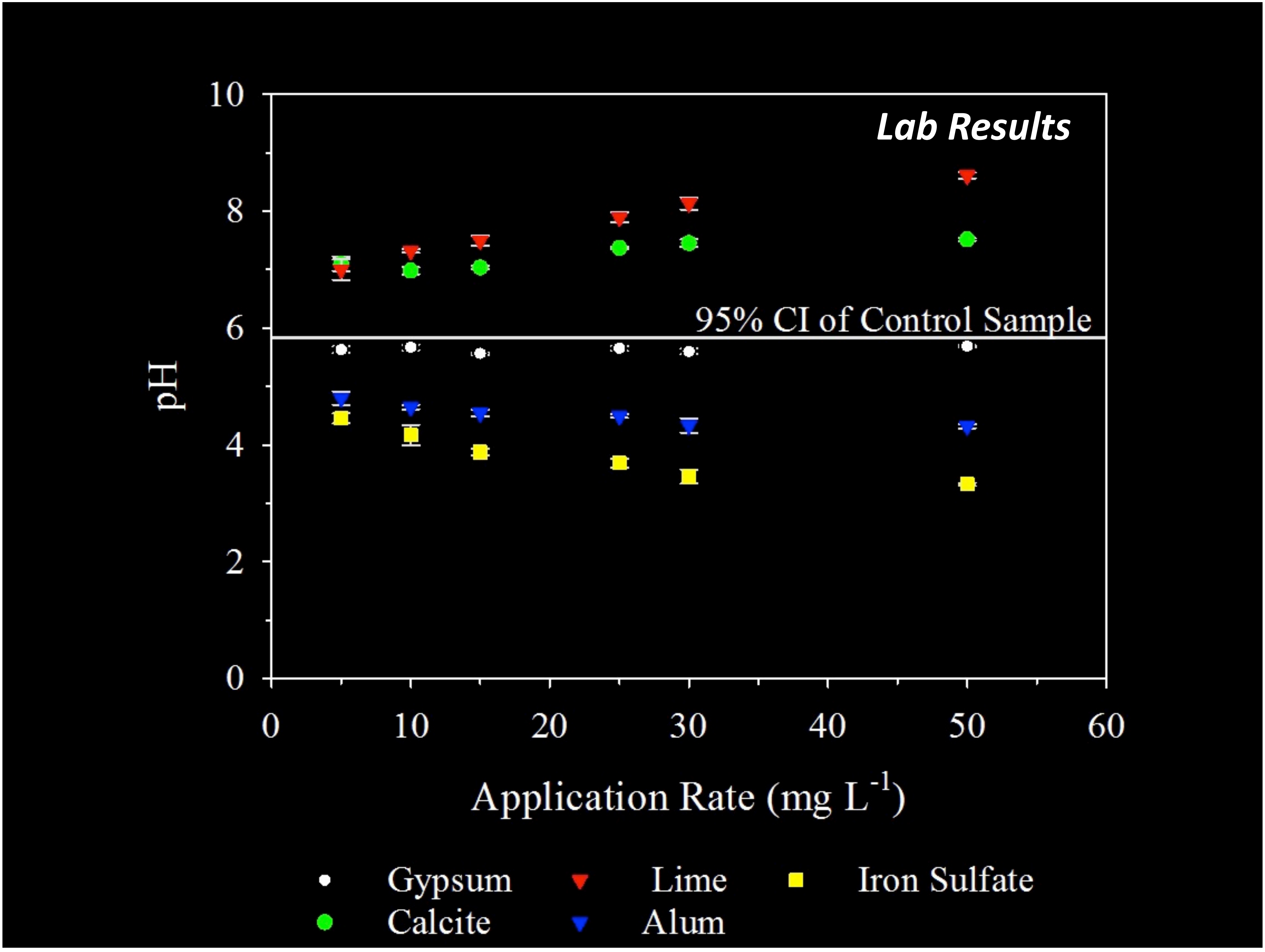
Alum

- Aluminum sulfate ($Al_2(SO_4)_3 \bullet 18H_2O$)
- Readily soluble in water (S = 36.4 g/100g)
- Waste water coagulant, dye, pickling agent



Lab Results
95% CI of Control Sample
Total P Concentration (µg P L-1)
Application Rate (mg L-1)
0
10
20
30
40
50
60
70
Gypsum
Lime
Iron Sulfate
Calcite
Alum

Sediment Flocculation

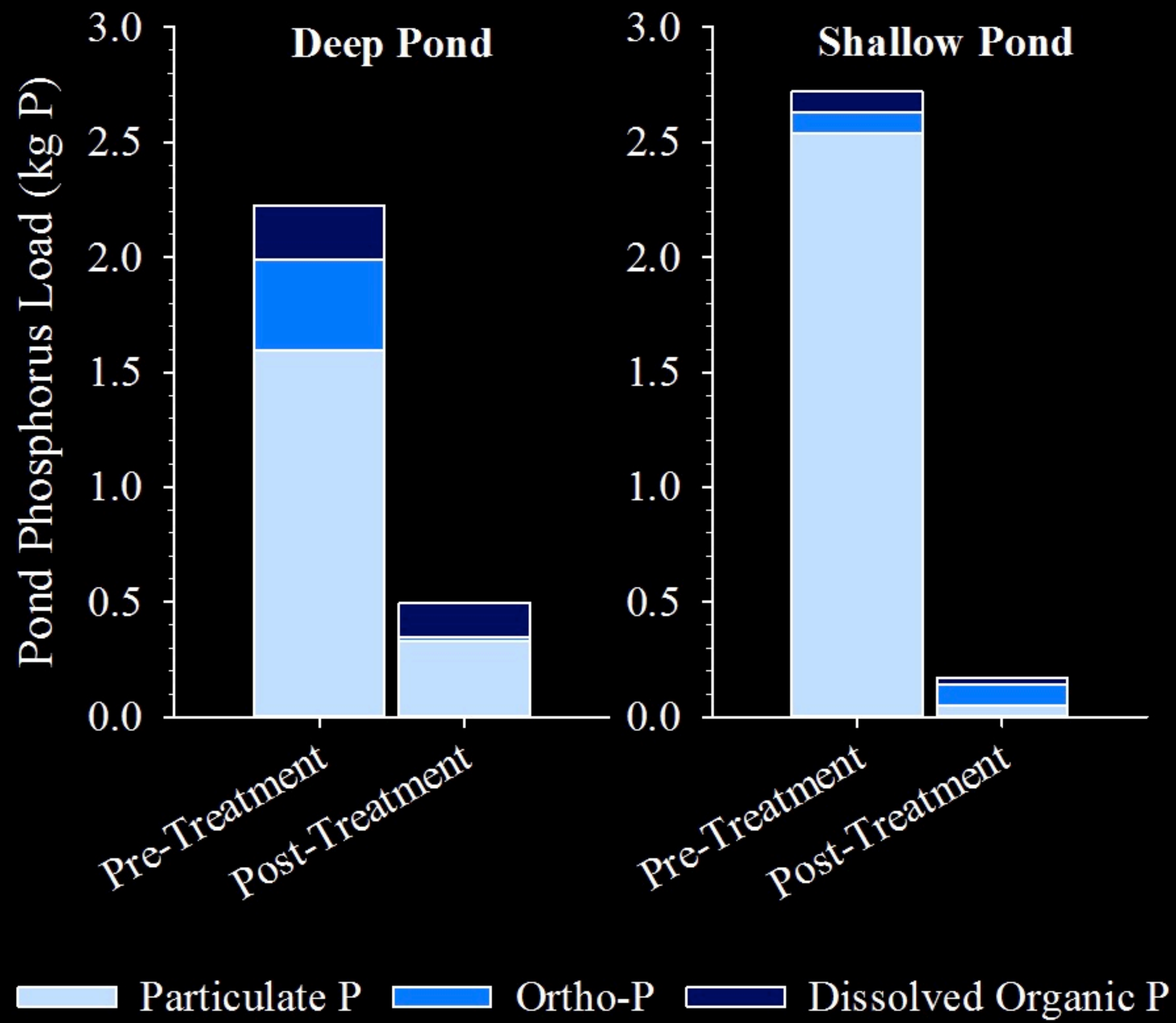


Lab Results
95% CI of Control Sample
pH
0
2
4
6
8
10
0
10
20
30
40
50
60
Application Rate (mg L-1)
Gypsum
Lime
Iron Sulfate
Calcite
Alum

Alum Application

Sand Barge

Field Results



Kennedy, C.D., P.J.A Kleinman, C.J. DeMoranville, K.R. Elkin, R.B. Bryant, A.R. Buda. 2017. Managing surface water inputs to reduce phosphorus losses in cranberry farms. *J. Environ. Qual.*, accepted.

Conclusions

- 80-90% reduction in pond P load
- Treated pond P concentration was 7-16 ug/L (TMDL target = 50 ug/L)
- Treatment of 8 mgal (30,000 m^3) of water totaled $1000 total (barge and alum)
- Possible application to harvest flood, but further research is needed

Acknowledgements

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Questions?